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Enhanced Product Realization

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PREFACE

This document highlights the activities of the Agile Manufacturing Working Group within the National Information Infrastructure Testbed. The Institute for Defense Analyses (IDA) has funded membership in this consortium through the Independent Research Program.

The authors would like to thank Ms. Betty Lawson of IDA and Dr. James Costa of Sandia National Laboratories for reviewing the paper and making substantive comments to improve the quality and clarity of the final draft. Ms. Shanti Sleight of Sandia also reviewed the section on homepage development and provided excellent instruction in how she created the homepages.

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SUMMARY

A. PURPOSE

This document describes the work accomplished by Institute for Defense Analyses (IDA) personnel in support of the National Information Infrastructure Testbed (NIIT) demonstration project on agile manufacturing.

B. BACKGROUND

In 1993 the Clinton administration unveiled its vision for improving government services, the economy, and the quality of life through the development of a National Information Infrastructure (NII). This infrastructure, built and maintained primarily by the private sector, would consist of state-of-the-art information technologies and services, and would support such business functions as electronic commerce, telemedicine, and manufacturing.

With the establishment of an Information Infrastructure Task Force in September 1993 to oversee the NII initiative, numerous organizations from a cross section of the United States have become involved with activities related to this initiative. One such organization is the National Information Infrastructure Testbed (NIIT). The NIIT was formed in 1993 to provide industry, government, research labs, and academia an opportunity to work as a consortium to solve real-world problems using advanced telecommunications technologies and applications for the NII. To accomplish this goal, consortium members donate personnel, equipment, products, and services needed to complete specific demonstrations, or projects. These projects are led by NIIT working groups that are established to support one specific business application.

One working group, established by the NIIT, is the Agile Manufacturing Working Group (AMWG). The AMWG is looking for advanced technology solutions that will aid the U.S. manufacturing sector in becoming more competitive. The manufacturing industry is examining advanced technologies that will allow for computer-aided design systems, concurrent engineering techniques, and just-in-time inventory controls to reduce manufacturing processing time, reduce costs, and improve product quality.

The AMWG was organized in June 1995 and given the task to develop a demonstration aimed at solving a manufacturing problem facing consortium members. In response to this task the AMWG solicited proposals from NIIT members, and accepted a proposal submitted by Caterpillar for a testbed demonstration. This proposal, titled Enhanced Product Realization (EPR), will demonstrate how the use of advanced information technologies can streamline its product modification process.

C. SCOPE

The Institute for Defense Analyses, an NIIT member since November 1995, has been an active contributor to the EPR project by attending working group meetings and participating in conference calls. Through this participation IDA has developed the project work schedule, developed metrics to measure project success, and revised the Caterpillar process flow by developing a draft of the graphic workflow process. IDA also worked on the development of World Wide Web home pages that will link all the project teams together during the actual demonstration—scheduled for late October or early November—and assisted in the development of a project video. In November 1996, an IDA staff member will participate on a panel at a related NIIT workshop.

D. CONCLUSIONS

Today, in the face of fiscal and personnel resource constraints placed on its global operations, the DoD needs to take advantage of lessons learned from the commercial sector in areas such as agile manufacturing. The ability to respond immediately to customer demands, and to have multimedia telecommunications services with suppliers and manufacturers, is vital to maintaining the logistics support required for the military services.

The changes in the manufacturing process being addressed by the EPR project may be of vital interest to the Department of Defense and its contractors. Improved and streamlined manufacturing processes should shorten delivery time on major weapon systems, provide a more flexible environment to support system modifications, increase communications with the actual users, and save money in the long run.

However, the use of agility is not limited to the manufacturing process. Lessons learned from the EPR project dealing with security of the Internet, collaboration over the Internet, and real-time video can be applied to many DoD operations or process.

Numerous functions, or functional areas, within the DoD enterprise are candidates for significant improvement through the efficient application of information technology and services. Some of these areas are electronic commerce, modeling and simulation, distributive training, intelligence assessments and dissemination, collaborative planning in support of operations, and command and control. Process improvement may be achieved not only by DoD itself, but also by the myriad contractors that support the Department.

The next step is to take the lessons learned and new technology solutions and extend them to similar government or industry problems. In many cases what has been developed for Caterpillar's Enhanced Product Realization project can be applied to the Department of Defense.

I. INTRODUCTION

In 1993 the Clinton administration unveiled its plan for a National Information Infrastructure (NII).[1] The report of the National Performance Review, released in September 1993, described the NII initiative along with goals and objectives to be achieved through the implementation of advanced information technology.[2] A central theme of the NII is to develop and implement state-of-the-art telecommunications and information services on a national basis to support such functions as electronic commerce, telemedicine, and manufacturing, to name a few. This theme is also present in business process reengineering (BPR) and corporate information management (CIM), two major initiatives of the Department of Defense.

Since the establishment of the Information Infrastructure Task Force in September 1993 to oversee the NII initiative, numerous organizations from a cross section of the United States have become involved with activities related to this initiative. One such organization is the National Information Infrastructure Testbed (NIIT).[3]

The NIIT was formed in 1993 to provide industry, government, research labs, and academia an opportunity to work as a consortium to solve real-world problems using advanced telecommunications technologies and applications for the NII. To accomplish this goal, consortium members donate personnel, equipment, products, and services needed to complete specific projects. Consequently, firms that may compete in the marketplace work side by side in the NIIT to overcome technology and interoperability obstacles. The testbed has achieved a remarkable record in its few short years of existence, bringing some of the most advanced telecommunication capabilities to reality.

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1 For a detailed description of the NII see Hansen and Schoenberger, *An Overview of the National Information Infrastructure*, IDA Document D-1697, September 1995.

2 The National Performance Review was a task force headed by Vice President Gore to prepare a report on "reinventing government." The resulting report was *From Red Tape to Results: Creating a Government that Works Better & Costs Less*, released September 1993.

3 The National Information Infrastructure Testbed officially changed its name to InfoTEST International on 16 September 1996.

The NIIT has permanent committees, such as the Infrastructure and Middleware Committees, which support all NIIT projects. As new application areas are proposed by industry, temporary or project-oriented working groups are formed to facilitate the deployment of an NIIT solution for the project. For example, the working groups supporting Health Care or Earth Sciences are active only during the periods in which they are deploying an NIIT project.

At the June 1995 NIIT annual membership meeting, a new committee was formed called the Agile Manufacturing Working Group (AMWG). As mentioned above, one of the administration's objectives for the NII was to enhance the U.S. manufacturing effort through the implementation of telecommunications and information services. Toward that goal, industry is employing technology to allow for computer-aided design systems, concurrent engineering techniques, and just-in-time inventory controls to reduce manufacturing processing time, reduce costs, and improve product quality. This new paradigm has come to be known as "agile manufacturing"; hence, the Agile Manufacturing Working Group.[4]

Each year the NIIT solicits proposals from industry (open to anyone, even nonmembers of the NIIT consortium). During the September 1995 annual meeting sessions devoted to specific working groups, the newly formed AMWG developed a Request for Proposal framework and revised the overall objective of its future project. Several participants, including Caterpillar, Hughes, Sandia, and Polaroid, gave briefings on how the NII is impacting their organizations relative to agile manufacturing or product realization.

Several organizations submitted proposals, and by January 1996 a proposal by Caterpillar, Inc., was selected as the project to be supported through the AMWG. The March 1996 Planning Meeting established an ambitious project schedule, with a goal of October 1996 for an initial operating capability of the NIIT solution to the Caterpillar proposal. Additional phases of the project will be scheduled after the completion of the initial phase.

The Agile Manufacturing Working Group (AMWG) developed a project mission statement which includes many aspects of the production process such as concept development, design, production or manufacturing, delivery, maintenance, and service.

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4 See Appendix A for a more detailed description of agility in the business model.

The purpose of a broad-based objective is to minimize exclusion of groups or organizations wishing to submit proposals and to encourage diversity in technology and application solutions to fulfill the testbed project.

The AMWG Request for Proposal included the following mission statement:

> Identify and run projects on a National Information Infrastructure Testbed (NIIT)-provided testbed that support a product realization process which is uniquely enabled by an emerging information infrastructure. These projects, when successfully run on the testbed, will have substantial value to the proposer(s), other NIIT members, and also serve as an example of the value and direction of the National Information Infrastructure. The product realization projects will typically involve one or more phases of concept development, design, production and/or manufacturing, delivery and support.[5]

The AMWG determined the resource and expertise needs of the project and contacted additional companies, research facilities, and universities to supplement the original membership. The AMWG also decided to refer to the project as Enhanced Product Realization (EPR) to coincide with industry terminology and minimize different interpretations by government and industry participants.

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5 Available by contacting the NIIT at 1517 Blake Street, Suite 201, Denver CO 80202.

II. THE CATERPILLAR PROPOSAL: ENHANCED PRODUCT REALIZATION

Caterpillar's business problem is to continually improve its responsiveness to customers in an environment that relies on multidiscipline, multinational teams to achieve quicker product realization. Specific solution(s) must integrate legacy systems and investments with leading-edge technologies, implement a secure environment, and provide a user-friendly interface (i.e., ease of use and access for both legacy and new applications).

As stated in the overview of the Caterpillar proposal,[1] the metrics by which the company measures success are time to market, quality, best in class, and market leadership. To meet these metrics and to overcome its business problem, Caterpillar developed the Enhanced Product Realization project for the NIIT.

A. PROJECT OBJECTIVES

Caterpillar's objective is to utilize advanced technologies to enhance current operating procedures, to improve production efficiency, to maintain market leadership, and improve its competitive advantage.

The objectives of the AMWG are to—

- Demonstrate secured access to shared information
- Incorporate technology and applications that can be easily adapted to a production environment
- Demonstrate product information management
- Demonstrate integrated product realization tools
- Demonstrate transparent access to services
- Demonstrate interoperability across different platforms (PCs, workstations, servers, etc.)

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1 Available by contacting the NIIT at 1517 Blake Street, Suite 201, Denver CO 80202.

- Demonstrate an efficient workflow for product realization including both internal and external participants
- Establish geographically distributed virtual teams with real-time collaboration capabilities
- Integrate solution with existing Caterpillar systems and applications

B. EPR SCENARIO

The AMWG developed a 5-day scenario focused on the real-world Caterpillar problem to quickly redesign a Caterpillar product to meet new requirements. Currently the product enhancement process takes 12 to 20 weeks. This process is displayed at Appendix B.

By deploying an Enhanced Product Realization (EPR) process, supported with advanced information technologies and services, Caterpillar's goal is to reduce the process time to 5 days. In order for Caterpillar to achieve the 5-day goal, the project relies upon collaborative efforts between suppliers, subcontractors, retailers and Caterpillar's international staff. Multidisciplined teams are formed by bringing together personnel from different locations. Depending on their individual roles, team members need to have access to different types of information to complete their portions of the process. Security is therefore essential to assure that only those with specific "need-to-know" are given access to data, that each team member has a pre-specified authority to manipulate or read data, and that a data-tracking or audit system is operational to document the enhanced product realization process.

An important requirement from the Caterpillar perspective is that legacy systems be integrated with the new technologies. In many cases, the final solution may be a new technology interface with a Caterpillar legacy system.

The EPR process steps for each of the 5 days are as follows:[2]

Day 1

(1) Team leader (lead designer of the responsible area) receives notification about a problem.

— Multimedia description of the problem sent to team leader.

— Team leader logs the problem (beginning of audit trail).

(2) Team is alerted about the problem.

— Team leader alerts team to the problem.

— Team leader determines if additional members are needed. If so, these individuals are added to the team and notified via e-mail and phone messages.

(3) Team leader creates an electronic file folder.[3]

— All pertinent data are pulled to the Product Data Management System (PDMS).

— Authorizations for team members to access this data set are set automatically at the creation of the team folder.

(4) A team video conference is held.

— Team members review the problem and field application.

— Resource requirements are established and management is notified.

— Dynamic workflow plan is developed which includes milestones, tasks, time, and resources.

— Team accesses additional information as needed.

— Each team member begins reviewing information independently.

— Team leader schedules a group video conference for Day 2.

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2 This is a working document created by Caterpillar and revised by the AMWG to facilitate NIIT members' understanding of the process so the appropriate technological solutions could be deployed.

3 This will be managed by a Product Data Management System (PDMS) tool to determine who has the latest version of the information.

Day 2

(1) Team leader facilitates team meeting using video conference, Shared X, and whiteboard.

- — Team identifies acceptance criteria (production volume, cost, performance specification, delivery time requirement).
- — Team determines enhancement requirements (e.g., field application has been changed, manufacturing technique improvement, quality of material, function/cost trade-off).
- — Team brainstorms solution.
- — Team leader updates workflow plan.

(2) Team members perform analysis and simulation.

(3) Analysts develop geometry alternatives.

(4) Material analysis, such as hardness test, microstructure, and heat transfer, is performed.

(5) A team meeting using video conference, Shared X, and whiteboard is held.

- — Team members compare analysis information with acceptance criteria.
- — Team reviews alternative designs and performs risk assessment.
- — Team discusses and evaluates trade-offs for cost, schedule, material, form, fit, and function.
- — Team decides on two or three design alternatives.

Day 3

(1) Manufacturer defines capability to produce alternatives.

(2) Team refines options by performing further analysis of options.

(3) Team conducts meeting using video conference, Shared X, and whiteboard.

- — Team compares design analysis results.
- — Team reaches consensus on solution.
- — Team decides to make the part.

(4) Team leader checks team folder to ensure it contains all pertinent and updated information.

(5) Team leader updates workflow plan.

Day 4

(1) Team leader performs logistics.

— Team leader and management authorize part production.

— Customer service department and dealer update inventory and part manuals.

(2) Team conducts meeting using video conference, Shared X, and whiteboard.

— Team performs a final team review.

— Team members sign of electronically.

(3) Team leader and management execute normal releasing step to make the part.

(4) Manufacturer initiates material processing.

Day 5

(1) Manufacturer produces and inspects the part.

(2) Team leader or dealer notify customer of new part.

(3) Team notifies service department of new part.

(4) Manufacturer prepares part for shipping.

Establishing a telecommunications network that will allow the various players in this scenario to interact requires the emerging technologies and a wide-area network described below.

C. TECHNOLOGIES, INFRASTRUCTURE, AND APPLICATIONS SUPPORTING THE PROJECT

Another essential element of NIIT projects is the integration of heterogeneous technologies to simulate a real National Information Infrastructure. Table II-1 summarizes the applications and technologies supporting the 5-day scenario.

Phase I of the Caterpillar proposal will involve five sites some performing multiple roles in four functional areas: manufacturing, design, analysis, and supply. Initially, the sites will be represented by members of the NIIT. Once the technologies are developed and tested in Phase I, the actual manufacturers, designers, analysts and suppliers will be connected in future EPR deployment phases.

Each NIIT participant is responsible for providing the necessary equipment and software for its site. The backbone portion of the infrastructure will rely on the Internet and equipment provided by Bay Networks.

Table II-1. Technology and Applications

	DAY				
TECHNOLOGY	1	2	3	4	5
TCP/IP	X	X	X	X	X
Shared X	X	X	X	X	X
Multimedia Conference	X	X	X	X	X
Whiteboard	X	X	X	X	X
PDMS	X	X	X	X	X
Digital Camera	X				
Desk Top Video	X	X	X	X	X
APPLICATION					
E-Mail/Open Mail	X	X	X	X	X
Pro/E	X	X	X	X	X
Rastar Images	X	X	X		
Weld Analysis		X	X	X	
Casting Solidification		X	X	X	
Finite Element		X	X	X	
NC Generation			X	X	
DFMA			X	X	
FMEA		X	X		

Each of the five sites in the EPR project is providing hardware such as clients (many will be Hewlett Packards, Silicon Graphics Indys, etc.), servers (MicroSoft NT), and telecommunications access lines (ranging from 256 kbps to 45 mbps). Routers will be provided by Bay Networks, although a couple of sites may provide their own CISCO routers. Figure II-1 depicts the typical Wide Area Network (WAN) architecture required to support this type of project.

The backbone of the network will reside on the Internet since this was widely used by many commercial firms. However, using the Internet rather than a dedicated (restricted) network necessitates additional security measures. Each site on the testbed network is responsible for providing its own firewall and on-site security measures. The

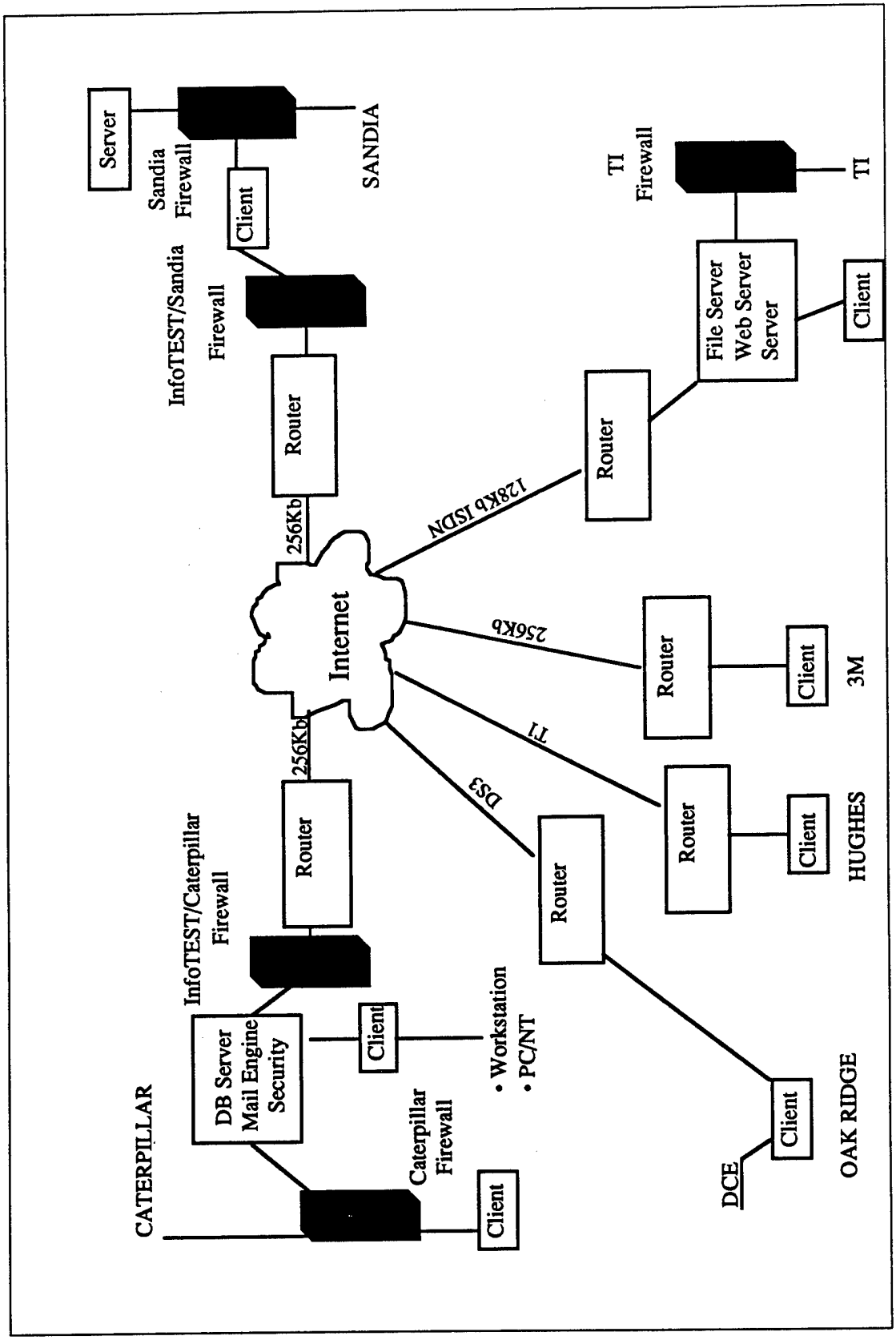

Figure II-1. EPR Wide Area Network

original plan was to use Distributed Computing Environment (DCE) software for the security, but in September 1996 the AMWG decided the cost was prohibitive for all sites to purchase licenses and modify all existing data bases to comply with DCE. The next phase of the project will adopt the new security feature (encryption) being imbedded within the Bay Networks routers.

In addition to security, other issues that require attention include access and authorization, deployment costs, integration with legacy systems, and the "weakest link" issue. In order for the EPR to work, each site must be able to support the technologies and applications. Therefore, it is critical as the project is expanded to include Caterpillar's real suppliers, field representatives, and manufacturers that the hardware and software requirements include all participants. For this reason, future phases may also incorporate additional technologies, such as wireless communications, laptop computers, and personal communications systems.

III. ROLE OF THE INSTITUTE FOR DEFENSE ANALYSES

The Institute for Defense Analyses, like other NIIT participants, has contributed to the planning of the EPR project. IDA has developed the work schedule, revised the Caterpillar process flow (IDA drafted the first graphic work-flow[1]), and participated in teleconferences and working group meetings. In many cases the brainstorming, questioning, and interactions at meetings have pushed the development of solutions, clarified and refined the requirements, and fleshed out the issues which need further study. IDA has also played a role in the development of a project video,[2] and a member of IDA will be a panel discussant at a related workshop in November 1996.

A. HOMEPAGE DEVELOPMENT

After a brainstorming session on the use of homepages to support aspects of enhanced product realization, IDA was assigned the lead to create the Project Management set of homepages. These pages will be linked to the main EPR homepage, which is being created by Texas Instruments.

Understanding the assignment at hand, but lacking the skills to create the Project Management homepages, IDA engaged the support of Sandia's summer intern, Ms. Shanti Sleight. These pages, when finalized, will be available at the NIIT/InfoTEST World Wide Web site whose address is http://www.niit.org. The Project Management homepage layout utilizes frames. This format, supported by most browsers, allows the window to be divided into several sections. The page consists of a banner along the top (which links to the InfoTEST homepage), a table of contents along the left side which permits users to redirect the main window space, and the main window which takes up the majority of the browser screen.

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1 Created by Janet Nauta from IDA. Caterpillar then modified the form and utilized a different software application so that the document could be updated as necessary.

2 "The Internet: America's Competititive Advantage" is available from InfoTEST International, 1517 Blake Street, Suite 201, Denver CO 80202, 1-800-299-9973.

The homepages have several goals: ease of use, linkage to Caterpillar data bases (future step when data bases exist), and creating a common way for team members to communicate. The EPR Project Management home pages are subdivided into four links:

- Team Selection
- Project Schedule
- Project Budget
- Project Management Information and Metrics

In September the Program Management homepages were developed and demonstrated to the AMWG. The Team Selection pages and links are complete.

During EPR's Phase II the Project Schedule, Project Budget, and Project Management Information and Metrics homepages will be completed, access security features will be introduced, and a team message board will be created.

The pages are being developed in BBEdit. One section of the homepages involves creating a team list form. The program to process the form is written in Perl language using an editor called EMACS. This creates a common gateway interface (CGI) which is run from the Web and allows a unique process to be performed based on the user's data input.

B. METRICS FRAMEWORK

Companies rarely make a decision to invest in leading-edge technologies until a business case has been evaluated. A part of the EPR project will be to define the metrics necessary to evaluate the cost, benefits, technology performance, and efficiency gains from the deployment of the Enhanced Product Realization project.

The first step is to identify those qualitative and quantitative measures that will be useful to all participants in the project. Participants developing the technical and interoperability solutions are concerned with network measures. Caterpillar will have specific management information, manufacturing, and company performance measures that will be important in its business case evaluation.

The following four categories comprise the benchmark metrics for measuring the success of the EPR project:

- *Performance metrics*—latency; packet or cell loss; link utilization; throughput; peering arrangements.
- *Reliability metrics*—physical route diversity, routing protocol convergence times; disaster recovery plan; backbone, exchange points, and access circuit availability.
- *Cost metrics*—equipment; software license fees; staff re-training; network support and maintenance; application support and maintenance.
- *Management metrics*—efficiency improvements; time to deliver; number of "cases" redesigned and evaluated; diversity and depth of data reviewed in process; team composition; customer satisfaction; user satisfaction; Phase I implementation time; external reaction.

Data for the metrics will be collected and analyzed during Phase II of the EPR project.

IV. CONCLUSION

A. PHASE II

In November 1996, the AMWG will develop a schedule for EPR Phase II. The following features of the testbed project could not be completed within the timeframe of Phase I: secure communications across the Internet, including implementation of an authentication mechanism; use of multi-cast/broadcast video; expansion of the homepages; development of interfaces to corporate data sources; and collection of data for metrics. It is envisioned that most, if not all, of these features will be demonstrated in Phase II.

B. APPLICABILITY TO THE DEPARTMENT OF DEFENSE

The work of the NIIT and its working groups, such as the AMWG, directly relates to the Department of Defense (DoD) initiative for business process reengineering (BPR). For instance the term "agile" as defined in today's commercial sector is exactly what BPR, formerly the Corporate Information Management (CIM) initiative, is all about. The need to change the process, to involve senior management and the customers, and to utilize state-of-the-art telecommunications and information systems to produce items when and where you need them is the real focus of BPR.

Today, in the face of fiscal and personnel resource constraints on its global operations, the DoD needs to take advantage of lessons learned from the commercial sector in areas such as agile manufacturing. The ability to respond immediately to customer demands, and to have multimedia telecommunications services with suppliers and manufacturers, is vital to maintaining the logistics support required for the military services.

The changes in the manufacturing process being addressed by the EPR project may be of vital interest to the Department of Defense and its contractors. Improved and streamlined manufacturing processes should shorten delivery time on major weapon sytems, provide a more flexible environment to support system modifications, increase communications with the actual users, and save money in the long run. In fact, there should be substantial improvement in all the metrics discussed in Chapter 2 (i.e.,

manufacturing cost, quality improvement, better delivery times, and improved system performance) for DoD.

However, the use of agility is not limited to the manufacturing process. Lessons learned from the EPR project dealing with security of the Internet, collaboration over the Internet, and real-time video can be applied to many DoD operations or process.

Numerous functions, or functional areas, within the DoD enterprise are candidates for significant improvement through the efficient application of information technology and services. Some of these areas are electronic commerce, modeling and simulation, distributive training, intelligence assessments and dissemination, collaborative planning in support of operations, and command and control. Process improvement may be achieved not only by DoD itself, but also by the myriad contractors that support the Department.

C. EXTENSION OF TESTBED RESULTS

The NIIT testbed activities such as the Enhanced Product Realization project provide important benefits that can be realized by the public, private, and government sectors. Participants resolve deployment and interoperability problems, test applications in real-world business settings, accelerate the creation and implementation of the National Information Infrastructure, identify future marketability of products and services, conceptualize other business or government applications for the NIIT project solutions, and interact with some of the most forward-looking and creative industry leaders. The testbed solutions are in themselves major milestones in advancing technology and interoperability, but, more important, they represent new markets for real-world applications of the technology. The next step is to take the lessons learned and new technology solutions and extend them to similar government or industry problems. In many cases what has been developed for Caterpillar's Enhanced Product Realization can be applied to the Department of Defense.

Appendix A
AGILITY IN A BUSINESS MODEL

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AGILITY IN A BUSINESS MODEL

The term agility in the business model can be traced at least to 1991, when the Iacocca Institute at Leigh University issued a report on manufacturing enterprise strategy.[1] Since then, there has been much discussion on what constitutes agility, and how will it improve the U.S. business. Probably one of the easiest definitions to understand is the description of agility in terms of process focus not product focus. This description implies that the overall process is flexible and readily adaptable to a changing environment.

Agility can also be expressed in terms of enabling a system or a process. Attributes contributing to agility as an enabler are integration, reconfigurability, cooperation, and flexibility. These terms come from a description of an agility system-level model.[2]

According to this definition, agile companies are more attuned to the needs and requirements of the customers. In particular, these organizations look at the value of products from the viewpoint of what is perceived as value by the customer.

Another way of looking at agile competition is to look at the differences associated with the metrics of mass production and agile production. Under the mass production scheme, metrics reflect a market environment in which:

- Lowest unit cost is the aim of competition
- Efficiency is function of direct costs
- Product value is associated with standardized pricing
- Sales are basically single-instance transactions

By contrast, agile metrics reflect variable pricing strategies that incorporate the individual values of the customers. Emphasis is shifted from the product and the

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1 R.N. Nagel and R. Dove, *21st Century Manufacturing Enterprise Strategy: An Industry-Led View,* Iacocca Institute at Lehigh University, Bethlehem, PA, 1991.

2 Model may be found on the Agility Forum home page on the World Wide Web URL: http://www.agilityforum.org/.

profitability of the product to the customer and the value of the product as seen by the customer. In an agile company, the relationship between the organization and the customer is long-term and interactive whereas a single transaction may typify the relationship between a mass producer and customer.

In moving to an agile system the corporation needs to focus on several factors, such as the overall process, the infrastructure, and the availability and use of information. Although the process and infrastructure are also key to becoming agile, this discussion will be limited to the re-thinking of information.

Information itself is viewed by many as a product. And, in this era of the "Information Superhighway," the almost instant availability and dissemination of information is giving rise to the viewpoint that information enabls successful competition. The ability to rapidly exchange information with customers supports the premise that the value of a product as perceived by the customer is becoming increasingly important in the corporate decision process.

Timely access, assessment, and use of information is critical in the production process of an agile corporation. By having state-of-the-art information systems in place, corporations can maintain real-time status of a process, determine problems and opportunities based on customer demands, fix schedules and allocate resources, predict the future state of each production process and recognize potential problems, and control execution.

The definition of agility itself leads to the conclusion that information is vital to a corporation, and that state-of-the-art telecommunications and information systems are critical in meeting the information requirements of that corporation.

Appendix B

CATERPILLAR'S CURRENT TASK WORKFLOW

Table B-1. Caterpillar's Current Task Work Flow

Process Steps	Duration today	Application	Tool	Who	Where	Data Location	Data Type	Data Volume	Hardware	Middleware	Network
Field Failure	2 days		SIMS	Customer/dealer	Dealer	Field	Voice, email, video	Low	SNA, terminal, phone, camera	TBD	Internet, TBD
Notification	2-4 weeks			System (TBD)	All sites	All sites	Electronic(??)	Low	Pager (TBD), email (TBD)	TBD	Internet, TBD
Collect Data	2-4 weeks	PDM, process, production, legacy DB	Production job extract	System (TBD)	All sites	Databases, paper, photos	CAD, relational DB, text, CAM, video	Gigabyte	IBM es9000,HP 700, 9000, AS-400	Security, naming ORB, DBMS, messaging	ATM, TBD
Identify Cause		Collaboration	Shared X, CAD	Team	All sites	Mainframe, server, desk top, workstation	CAD, relational DB, text, CAM, video	Gigabyte	HP's (TBD)	Security, naming, ORB, DBMS, messaging	ATM, TBD
Evalute alternatives		Simulation	CAD, Pro/Mach, Nastran, Master Casting, Sim, Series, Pro/Man	Team	All sites	TBD	Cad, relational DB, text,CAM, video	Gigabytes	HP's (TBD)	Security, naming, ORB, DBMS, messaging	ATM, TBD
Pick Solutions	4-6 weeks	Collaboration	Shared X	Team	All sites	TBD	CAD, relational DB, text, CAM, video	Gigabytes	HP's (TBD)	Security, naming, ORB, DBMS, messaging	ATM, TBD
Make part	4-6 weeks	Machine tools	Lathes, lasers, welding	Manufacturers	Mainframe, server, desk top, workstation	Mainframe, server, desk top, workstation	CAD, relational DB, text, CAM, video	Gigabytes	Manfucturer's	NA	NA
Communicate											

Appendix C
GLOSSARY

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GLOSSARY

3M	Minnesota Mining and Manufacturing, Inc. A consortium member of the NIIT.
AMWG	Agile Manufacturing Working Group. A project-oriented committee of the NIIT.
Bay Networks	A consortium member of the NIIT.
BPR	Business Process Reengineering
Caterpillar, Inc.	A consortium member of the NIIT.
CGI	Common Gateway Interface
CIM	Corporate Information Management
DCE	Distributed Computing Environment, software protocol which supports security, developed by Open Systems Foundation.
DFMA	Design for Manufacturability and Assembly
DoD	Department of Defense
EAO	Engineering Authorization Order
EMACS	An editor used in the development of homepages.
EPR	Enhanced Product Realization, improvements to manufacturing or service delivery through new technologies, process improvements or other means. The Agile Manufacturing Working Group of the NIIT is supporting a EPR project.
FMEA	Failure Mode Effect Analysis
HP	Hewlett Packard Inc. A consortium member of the NIIT.
Hughes Corp.	A consortium member of the NIIT.
IDA	Institute for Defense Analyses. A consortium member of the NIIT.
InfoTEST, International	New name for the NIIT.
NC	Numeric control
NII	National Information Infrastructure

NIIT	National Information Infrastructure Testbed, renamed InfoTEST, International in September 1996.
Oak Ridge National Lab	A consortium member of the NIIT.
PDMS	Product Data Management System, a software application which manages data.
Peer Logic, Inc.	A consortium member of the NIIT.
Pro/E	An engineering design software application.
Rastar	Type of engineering application which produces images.
Sandia National Lab	A consortium member of the NIIT.
TCP/IP	Transmission Control Protocol/Internet Protocol
TI	Texas Instruments, Inc. A consortium member of the NIIT.
WAN	Wide Area Network

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13. ABSTRACT (Maximum 200 words)

To enhance IDA's understanding of the technical, interoperability, and security issues pertaining to the implementation of customer driven applications, such as agile manufacturing, IDA renewed its membership in the National Information Infrastructure Testbed (NIIT), and the project team actively participated in the NIIT's Agile Manufacturing Working Group Project on Enhanced Product Realization. This document describes the work accomplished by IDA personnel in support of a demonstration project on agile manufacturing sponsored by the NIIT. Through this participation, IDA representatives were involved with project planning and determination of the telecommunications infrastructure required to support the project. They also were involved with security issues, interoperability issues, development of metrics for measuring project success, and development of World Wide Web pages linking various project teams together. An increased understanding of these issues has positioned IDA to support the Defense Information Systems Agency (DISA) and other DoD agencies in such areas such as security of DoD networks, network interoperability, dual use technology, and expanded use of the Internet.

14. SUBJECT TERMS

agile, agility, central research program, collaboration, CRP, InfoTEST, manufacturing, metrics, NII, NIIT, National Information Infrastructure, National Information Infrastructure Testbed

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